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# ESCAP II: Sensitivity Analysis for the Assessment of the Synthetic Assumption

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U S C E N S U S B U R E A U

*Helping You Make Informed Decisions*

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## **ESCAP II:**

# **Sensitivity Analysis for the Assessment of the Synthetic Assumption**

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## **Executive Summary**

The Accuracy and Coverage Evaluation methodology produces estimated coverage correction factors for each of the post-strata. These factors are applied or carried down within the post-strata to the census block level. This process is referred to as synthetic estimation. The key assumption underlying this methodology is that the net census coverage, estimated by the coverage correction factor is relatively uniform within the post-strata. Failures of this assumption lead to synthetic error.

The Census Bureau is concerned with synthetic error since it is not included directly in the total error model. The analysis of the effects of synthetic error presented in this memorandum is based on the construction of “artificial populations.” These are populations that are created with surrogate variables that are known for the entire population, and are developed to reflect the distribution of net coverage error. An analysis of these populations for the effect of synthetic error is the basis on which this otherwise unknown effect is studied.

Griffin and Malec (2001,B-14\*) examined the effect of synthetic error on a limited number of loss functions analyzed by Navarro and Asiala (2001,B-13\*). This was necessary since the loss function results do not include a measure of error due to the synthetic assumption. This analysis looks at the effect of synthetic error on more loss functions to determine whether this approach is sensitive to the bias components assumed in the loss functions. Six “artificial populations” are studied to partially overcome the inherent limitations with any such study. Schindler (2001) provides an alternative assessment based on direct dual system estimators at a state level. Each of these analyses has their own set of different assumptions and limitations.

Before examining the results, it is important to understand the limitations.

### **What are the limitations of this study?**

- All of the loss functions studied in this report make extensive use of the 1990 Post Enumeration Survey evaluations to estimate biases as was done by Navarro and Asiala (2001). Thus, these loss function results use Total Error Model results as of February 2001. Total Error Model and new loss function results from the 2000 Accuracy and Coverage Evaluation (A.C.E.) are not available for this report.
- Artificial populations were created using surrogate variables, available for small areas,

correlated with gross undercount and/or gross overcount. The surrogate variables are not the variable of interest and the correlations of the selected surrogates were smaller than we would have preferred. No artificial population provides the true population count for any geographic area.

### **What implications do these results have on the adjustment decision?**

Concerns about synthetic error should not be a major factor in the adjustment decision. The following highlights our major findings, subject of course to the limitations noted.

- Loss function decisions for state counts were not affected by synthetic bias for any of the sets of alternative assumptions analyzed. Eighteen of 96 alternatives analyzed for state shares show a change in the loss function decision due to a synthetic bias correction. Most of these change a decision in favor of adjustment to a decision in favor of the Census.
- Two of 96 alternatives analyzed for congressional district shares show a change in the loss function decision due to a synthetic bias correction. Both of these change a decision in favor of the Census to a decision in favor of adjustment.
- The bias of a synthetic estimate can be split into two components: (1) the synthetic population bias due to carrying the post-stratum level net coverage adjustment down to sub-national levels and (2) bias in the post-stratum level Dual System Estimation (DSE) including correlation bias. For congressional district counts, 54 of 64 artificial population/bias combinations have an average ratio of synthetic population bias to post-stratum level DSE bias of less than 1. The median ratio over these 64 combinations is 0.29. For state counts, 60 of 64 artificial population/bias combinations have an average ratio of synthetic population bias to post-stratum level DSE bias of less than 1. The median ratio over these 64 combinations is 0.15. Thus, for most areas, for synthetic estimates the synthetic population bias is less than the post-stratum level DSE bias.

## Conclusions

Using the loss functions available in February 2001 which make extensive use of 1990 Post Enumeration Survey biases, we found:

- The sensitivity of loss function results to variations in DSE bias and artificial populations are low, especially for state counts and Congressional District shares.
- State shares are more sensitive to variations in DSE bias assumptions and artificial populations than state counts and congressional district shares. However, there are more combinations that have a loss function decision that was not changed by the synthetic bias correction.
- For most areas, for synthetic estimates the synthetic population bias is less than the post-stratum level DSE bias.

# Introduction

The synthetic assumption states that census net coverage does not vary within post-strata. For example, the synthetic assumption implies that census counts in St. Louis, Missouri in a given post-stratum have the same net coverage as the census counts in the same post-stratum but in Milwaukee, Wisconsin. The synthetic assumption within post-strata will permit the Census Bureau to draw conclusions from the A.C.E. sample about the population as a whole, to individuals living in geographic areas smaller than post-strata. The synthetic assumption is necessary to permit correction for small geographic areas based on a sample. This adjustment is only correcting for systematic biases and not local census errors. The error that is introduced when the synthetic assumption does not hold is called synthetic error.

Assessments of the 1990 Post Enumeration Survey (PES) were concerned with the possibility that synthetic error introduced error in the PES, especially for low levels of geography such as blocks. Synthetic error is of greater concern for small areas than for larger geographic aggregations. It is acknowledged that synthetic error will likely result in the population of some blocks being overestimated and the population of other blocks being underestimated; statistical correction is not expected to produce unqualified improvement in the smallest geographic areas, like blocks.

While the accuracy of the A.C.E.'s synthetic estimates depends on the degree in which net coverage varies within post-strata, it is important to understand that perfectly equal net coverage cannot exist within all post-strata. The Census Bureau's evaluation of synthetic error should focus on whether the variability of net coverage is so great as to prevent an improvement from using the A.C.E. Additionally, the A.C.E. was designed to reduce the variability of net coverage as compared with the 1990 PES. The A.C.E. design has enhanced post-strata, including variables for mail return rate and type of enumeration areas. In addition, the census has net coverage that varies across areas.

The loss function results reported in Navarro and Asiala (2001) did not include a measure of error due to the synthetic assumption. B-14\* presented the effect of this bias on the loss function results. All loss function results presented in B-14\* used one of eight sets of assumptions dealing with correlation bias and processing error and one of two methods to synthetically distribute total error model targets to states and congressional districts (Model 6 and Synthetic Method 1, see Tables 1 and 2). This report is a sensitivity analysis of the effect of varying these eight assumptions and two methods on the assessment of the effect of synthetic error on the Loss function Analysis. Two additional artificial populations are studied in addition to the four artificial populations examined in B-14\*. Note that all results rely heavily on the biases estimated for the 1990 PES.

## Overview of methodology

This section describes the essence of estimating the effect of synthetic error on loss function results. The Appendix provides the mathematical details of the methodology.

### *Creation of artificial populations*

We use census variables thought to be related to coverage to produce artificial populations. Call these variables surrogates. We use methodology similar to one method suggested by Freedman and Wachter (1994). We adjusted one surrogate variable to weighted omissions and another to weighted erroneous enumerations. This is done by distributing the post-stratum level weighted omissions (weighted erroneous enumerations ) proportional to the weighted omissions surrogate variable (weighted erroneous enumeration surrogate variable) for the congressional districts. These are added and subtracted to census counts to form an artificial population count. A correction for the bias in the post-stratum level DSE (for alternative correlation bias and processing error assumptions) is allocated to the artificial population count for each congressional district. Congressional Districts are added to get state counts. (see Appendix). Unlike other approaches, this strategy can provide both net over- and under- coverage between local areas within a post-stratum. It is possible that the surrogates that are best for weighted omissions are different than those that are best for weighted erroneous enumerations. All artificial population counts summed over congressional districts and post-strata are equal to the targets counts used in the loss function analysis (for alternative correlation bias and processing error assumptions).

The surrogate variables considered are:

- Allocations - Households with more than a specified amount of item nonresponse (Items include race, Hispanic origin, relationship, sex, and age)
- Number of Non-Mail Returns
- Number of Substitutions - Whole-household imputes and/or partial household substitutions
- Number of duplicates added back (late adds)
- Units at basic street address

Allocations, substitutions, multi-unit, and non-mail back were surrogates used by Freedman and Wachter (1994). They also used mobility and poverty which are Census 2000 long form data items not available at this time.

At the A.C.E block cluster level, within post-strata, one can construct an indicator of total coverage, the coverage gap, as follows:

$$z = (\text{weighted P-sample non-matches}) - (\text{weighted E-sample erroneous enumerations})$$

At the block cluster level, a correlation between  $z$  and each artificial population's estimated true net coverage error (see Appendix for details) can be made. Note that each artificial population uses two surrogate variables, one for weighted omissions and one for weighted erroneous enumerations. Because of the possibly large amount of geocoding error at the block cluster level, these correlations will likely be small. Large correlations may merely mean that our artificial populations are related to geocoding error. Whatever the case, the correlations may be used to help rank the artificial populations in order of importance. From this analysis, multiple sets of artificial populations are selected for calculation of the error of synthetic estimates.

### *Sensitivity of Loss Function Results*

The loss function results reported in Navarro and Asiala (2001) do not include an error component for the failure of the synthetic assumption used to create the target counts. An expression for a bias correction to a squared error loss function difference,  $\text{Loss}(\text{Census}) - \text{Loss}(\text{A.C.E.})$  is shown in the Appendix. This bias correction term can be added to loss function results to correct for the bias of excluding synthetic error in the loss function analysis. The interpretation of the bias correction term is most relevant in terms of the sign of the squared error loss function difference. If the loss function difference is positive, indicating adjustment is favorable, only a negative bias correction can change this making adjustment unfavorable. Similarly, if the difference is negative, indicating adjustment is not favorable, this can be reversed only if the bias correction is positive. The amount of bias being added or subtracted must be larger than the absolute difference to reverse the outcome.

### *Variations in assumptions used in Sensitivity analysis*

Loss function results for states and congressional districts are reported for eight different sets of correlation bias and processing error assumptions and for two methods of synthetically carrying down targets from the evaluation post-stratum level to the production post-stratum level.

The eight sets of correlation bias and processing error for states and congressional districts are as follows:

Table 1: Sensitivity Analysis Bias Models for States and Congressional Districts

Model 1 - Corr. Bias Males 18+; 100% Proc. Error
Model 2 - Corr. Bias Males 18+, except Non-Black Males 18-29; 0% Proc. Error
Model 3 - Corr. Bias Males 18+, except Non-Black Males 18-29; 25% Proc. Error
Model 4 - Corr. Bias Males 18+, except Non-Black Males 18-29; 50% Proc. Error
Model 5 - Corr. Bias Males 18+, except Non-Black Males 18-29; 75% Proc. Error
Model 6 - Corr. Bias Males 18+, except Non-Black Males 18-29; 100% Proc. Error
Model 7 - Corr. Bias Black Males 18+; 100% Proc. Error
Model 8 - No Corr. Bias; 100% Proc. Error

For Models 1 through 7 the degree of correlation bias is 100 percent.

The two methods of synthetically carrying down targets for states and congressional districts are as follows:

Table 2: Sensitivity Analysis Synthetic Methods

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**Method 1 - Proportional to Gross DSE**

**Method 2 - Proportional to Gross Undercount**

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## Results

### **What are the results of the surrogate variable selection used for artificial population creation?**

Based on the block cluster level correlation analysis, four sets of artificial population surrogate variables were selected as described in Table 3 for Artificial Populations 1, 2, 3, and 4. For each of these four artificial populations the count was corrected for DSE bias proportional to the census counts. Note that for Artificial Populations 2 and 4 the same surrogate variable is used for weighted omissions and weighted erroneous enumerations. Thus if the post-stratum has an overall undercount (overcount) all local areas will have an undercount (overcount) correction for that post-stratum for these artificial populations. Artificial populations 5 and 6 use the same surrogate variables as Artificial Populations 2 and 4 respectively. For these two artificial populations the count was corrected for DSE bias proportional to the single surrogate variable. See the Appendix for details. Among all the combinations of weighted omissions and weighted erroneous enumerations surrogates considered, these were the four that had the highest correlations. Artificial population 4 had the highest correlation among potential artificial populations that excluded remainder surrogates (such as, excludes surrogates formed by subtracting the number of persons with a characteristics such as substituted from the total number of persons). Typical correlations obtained ranged from slightly negative to around 0.26.

Table 3: Surrogate Variables used to Create Artificial Populations

	<b>Correlations (weighted analysis)</b>	<b>Undercount Surrogate</b>	<b>Overcount Surrogate</b>	<b>Correction for DSE bias proportional to:</b>
Artificial Population 1	0.26	# non-substituted persons in households	#persons for whom reported date of birth and reported age were consistent (allocation not required)	Census Counts
Artificial Population 2	0.27	# non-substituted persons in households	# non-substituted persons in households	Census Counts
Artificial Population 3	0.26	# persons with 2 or more items allocated	#persons for whom reported date of birth and reported age were consistent (allocation not required)	Census Counts
Artificial Population 4	0.25	# persons whose household did not mail back the questionnaire	# persons whose household did not mail back the questionnaire	Census Counts
Artificial Population 5	0.27	# non-substituted persons in households	# non-substituted persons in households	Surrogate Variable
Artificial Population 6	0.25	# persons whose household did not mail back the questionnaire	# persons whose household did not mail back the questionnaire	Surrogate Variable

Household Persons only (Group Quarters Persons are Excluded)

## Is the A.C.E. or Census More Accurate?

For each of the indicated DSE bias models and two distribution methods, Tables 4-6 show the uncorrected loss function result (under none for artificial population), and the corrected loss function result for each of the six artificial populations. "ACE" indicates the A.C.E. had less error and "CEN" indicates the Census had less error (as measured by the appropriate weighted squared error loss function). A shaded table cell indicates that the loss function decision changes as a result of correcting for synthetic bias.

- Tables 4, 5, and 6 summarize the results for weighted state levels, weighted state shares, and Congressional District (CD) Shares respectively. Detailed numerical results are provided later in this memorandum.

### ESTIMATED STATE LEVELS

- For estimated state levels (Table 4), the synthetic bias correction does not change the decision for any of the ninety-six bias model/artificial population/synthetic distribution method combinations.

### ESTIMATED STATE SHARES

- For estimated state shares (Table 5), 18 of the 96 combinations have a bias correction which changes the decision.
- Six of the eight bias models have two combinations with a change.
- Bias Model 2 and Bias Model 3 have three combinations with a change.
- Fourteen of the 18 combinations with a change have distribution method proportional to the undercount (UC).
- Sixteen of these 18 combinations change a decision in favor of adjustment to a decision in favor of the Census. These are all from Artificial Populations 4 and 6.
- The other two combinations change a decision in favor of the Census to a decision in favor of adjustment. Both of these are for Artificial Population 3.

### ESTIMATED CD SHARES

- For estimated CD shares (Table 6), only 2 of the 96 combinations have a bias correction which changes the decision. Both of these are for Bias Model 8 and Artificial Population 3 and change a decision in favor of the Census to a decision in favor of adjustment.

## What is the effect of synthetic error on the weighted squared error loss function analysis for states?

Tables 7a through 8b show bias correction terms for estimated state counts and shares for combinations of artificial population (see Table 3), bias model (see Table 1), and synthetic distribution method (see Table 2). Column 1 is the artificial population number, Column 2 is the bias model number, and Column 3 is the synthetic distribution method number. For each combination, Column 4 is the weighted census squared error loss minus the weighted adjusted or A.C.E. squared error loss. This has a bias due to excluding synthetic error. Column 5 is the synthetic bias correction term. Column 6 is the relative bias (Column (5) / column (4)). Column 7 is the bias corrected weighted loss function difference (Column (4) + Column (5)). Column 8 indicates if this bias correction changes the decision. In order for this to happen the sign of Column 4 must be different than the sign of Column 7. If Column 4 is positive and Column 7 is negative then a decision in favor of adjustment has changed to a decision in favor of the Census. If Column 4 is negative and Column 7 is positive then a decision in favor of the census has changed to a decision in favor of adjustment.

A negative relative bias (Column (6)) indicates that the bias correction is in the direction towards reversing a decision. As explained in the methodology overview, (1) if the loss function difference is positive, indicating adjustment is favorable, only a negative bias correction can change this making adjustment unfavorable and (2) if the difference is negative, indicating adjustment is not favorable, this can be reversed only if the bias correction is positive. The amount of bias being added or subtracted must be larger than the absolute difference to reverse the outcome.

### STATE LEVEL COUNT ESTIMATES

For state level count estimates bias models 1 through 4 and 5 through 8 (Tables 7a and 7b respectively), the synthetic bias correction does not change the decision for any of the ninety six bias model/artificial population/synthetic method combinations. For these tables the weight,  $w$ , used in the squared error loss function is defined as:

$$w = \frac{1}{\text{state population}}$$

For the loss function difference, the A.C.E. loss used A.C.E. state estimates for the weight and the Census loss used Census state counts for the weight. However, to derive the bias correction term (see Appendix) we assumed these weights were equal and used census data for both weights.

Seventy three of the ninety six combinations have a negative relative bias indicating a bias correction in the direction of reversing a decision. All of these are less than 100 percent in absolute value so no decisions are reversed. The average absolute relative bias for these seventy-three combinations is 1.9 percent indicating that synthetic bias is not an important consideration for the loss function results for state level count estimates.

## STATE SHARE ESTIMATES

For state share estimates for bias models 1 through 4 (Table 8a), there are ten combinations of artificial population/synthetic method (out of 48) for which the synthetic bias correction changes the decision. For state share estimates for bias models 5 through 8 (Table 8b), there are eight combinations of artificial population/synthetic method (out of 48) for which the bias correction changes the decision. Six of the eight bias models have two combinations with a change. Bias Model 2 (Correlation Bias except for Non-Blacks ages 18-29, 0% Processing Error) and Bias Model 3 (Correlation Bias except Non-Blacks ages 18-29, 25% Processing Error) have three combinations with a change. Fourteen of the total eighteen combinations with a change have synthetic method 2 (proportional to gross undercount). Sixteen of these eighteen combinations change a decision in favor of adjustment to a decision in favor of the Census. These are all from Artificial Populations 4 and 6. The other two combinations change from a decision in favor of the Census to a decision in favor of adjustment. Both of these are from Artificial Population 3.

For these tables the weight,  $w$ , used in the squared error loss functions is defined as:

$$w = \frac{1}{\text{state share (of U.S. population)}}$$

For the loss function difference, the A.C.E. loss used A.C.E. state estimated shares for the weight and the Census loss used Census state shares for the weight. However, to derive the bias correction term (see Appendix) we assumed these weights were equal and used census data for both weights.

Seventy-two of the ninety-six combinations have a negative relative bias indicating a bias correction in the direction of reversing a decision. Fifty-four of these are less than 100 percent in absolute value so that decisions are not reversed for fifty-four of these seventy-two combinations. The average absolute relative bias for the fifty-four combinations is 15.2 percent indicating that synthetic bias would have to be much larger on average to reverse most decisions.

The 18 combinations that have a bias correction that reverses the decision have an average absolute relative bias of 312 percent these combinations have a very strong indication that the loss function decisions should be changed. Sixteen of the eighteen changed from in favor of adjustment to in favor of the Census.

## **What is the effect of synthetic error on the weighted squared error loss function analysis for congressional districts?**

Tables 9a and 9b are for Congressional District (CD) shares and the columns are defined the same as for Tables 7a through 8b.

Using the Equal CD Squared Error Loss census or adjusted shares are compared with target shares using loss functions with a weight,  $w$ , defined as:

$$w = (\text{total population for the CD's state})^2 .$$

Thus, each congressional district in the same state has the same weight.

For the loss function difference, both the A.C.E. loss and the Census loss used Census state counts for the weight.

Table 9a is for Bias Models 1 through 4 and Table 9b is for Bias Models 5 through 8. Only two of the 96 artificial population/bias model/synthetic distribution method combinations in Tables 9a and 9b have a bias correction which changes the decision. Both of these are for Bias Model 8 (No Correlation Bias, 100% Processing Error), Artificial Population 3 and change a decision in favor of the Census to a decision in favor of adjustment.

Seventy-two of the ninety-six combinations have a negative relative bias indicating a bias correction in the direction of reversing a decision. All but two of these are less than 100 percent in absolute value so that decisions are not reversed for seventy of these seventy-two combinations. The average absolute relative bias for the 70 combinations is 16.6 percent indicating that synthetic bias would have to be much larger on average to reverse most decisions.

The two combinations that have a bias correction that reverses the decision have extremely large absolute relative biases so these combinations have a very strong indication that the loss function decisions in favor of the Census should be changed to a decision in favor of adjustment.

## **Summary**

For estimated state counts, state shares, and congressional district shares, we estimated bias corrections for loss function differences (census loss - A.C.E. loss) that did not previously account for synthetic error. For each estimate for a given loss function, combinations of artificial population/bias model/synthetic method were analyzed to see if the synthetic bias correction would change the previous loss function decision. Using the loss functions available in February 2001 which make extensive use of 1990 Post Enumeration Survey biases, we found:

- For state counts the synthetic bias correction did not change the loss function decision for any of the 96 combinations examined.

- For state shares, each of the eight Bias Models had at least two artificial population/synthetic method combinations with a change in loss function decision due to the synthetic bias correction. There was a total of eighteen combinations (out of 96) with a change and sixteen of these changed a decision in favor of adjustment to a decision in favor of the census.
- For congressional district shares, only two of the ninety-six combinations resulted in a synthetic bias correction that changes the loss function decision. Both of these are for Bias Model 8 (No Correlation Bias, 100% Processing Error) and change a decision in favor of the Census to a decision in favor of adjustment.
- The bias of a synthetic estimate can be split into two components: (1) the synthetic population bias due to carrying the post-stratum level net coverage adjustment down to sub-national levels and (2) bias in the post-stratum level DSE including correlation bias. For most areas studied, for synthetic estimates the synthetic population bias is less than the post-stratum level DSE bias.

## References

Fay, R.E. and J. Thompson (1993). "The 1990 Post Enumeration Survey Statistical Lessons in Hindsight." Proceedings of the 1993 Annual Research Conference. U.S. Bureau of the Census, 71-91.

Freedman, D. and K. Wachter (1994). "Heterogeneity and Census Adjustment for the Intercensal Base." Statistical Science, 476-485.

Griffin, R. and Malec D. (2001). "Accuracy and Coverage Evaluation: Assessment of Synthetic Assumption" DSSD Census 2000 Procedures and Operations Memorandum Series B-13\*, February 28, 2001.

Hengartner, N. and T.P. Speed (1993). "Assessing Between-Block Heterogeneity Within the Post-Strata of the 1990 Post Enumeration Survey." Journal of the American Statistical Association, 88, 1047-1057.

Kim, J.J., A. Zaslavsky, and R. Blodgett (1995). "Between-State Heterogeneity of Undercount Rates and Surrogate Variables in the 1990 U.S. Census." Survey Methodology, 21, 1, pp.55-62.

Navarro, A. and M. Asiala, (2001). "Accuracy and Coverage Evaluation: Comparing Accuracy." DSSD Census 2000 Procedures and Operations Memorandum Series B-13\*, February 28, 2001.

Schindler, E, (2001). " Accuracy and Coverage Evaluation: "Alternative Assessment of Synthetic Assumption.", DSSD Census 2000 Procedures and Operations Memorandum Series Q-xx, September 2001.

**Table 4.**

**A.C.E. or Census More Accurate for State Levels?**

Shaded cell indicates a change in loss function decision due to synthetic bias									
Model	DSE Bias <sup>1</sup>	Distr. Method	Synthetic Bias Model (Artificial Population)						
			None	1	2	3	4	5	6
1	Corr. Bias Males 18+; 100 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
2	Corr. Bias Males 18+, except NB Males 18-29; 0 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
3	Corr. Bias Males 18+, except NB Males 18-29; 25 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
4	Corr. Bias Males 18+, except NB Males 18-29; 50 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
5	Corr. Bias Males 18+, except NB Males 18-29; 75 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
6	Corr. Bias Males 18+, except NB Males 18-29; 100 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
7	Corr. Bias Black Males 18+; 100 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
8	No Corr. Bias; 100 % Proc. Error	DSE UC	CEN CEN	CEN CEN	CEN CEN	CEN CEN	CEN CEN	CEN CEN	CEN CEN

<sup>1</sup>Except for correlation bias, the other bias components are based on 1990 PES evaluations.

**Table 5. A.C.E. or Census More Accurate for State Shares?**

Model	DSE Bias <sup>2</sup>	Distr. Method	Synthetic Bias Model (Artificial Population)						
			None	1	2	3	4	5	6
1	Corr. Bias Males 18+; 100 % Proc. Error	DSE	ACE	ACE	ACE	ACE	ACE	ACE	ACE
		UC	ACE	ACE	ACE	ACE	CEN	ACE	CEN
2	Corr. Bias Males 18+, except NB Males 18-29; 0 % Proc. Error	DSE	ACE	ACE	ACE	ACE	CEN	ACE	CEN
		UC	CEN	CEN	CEN	ACE	CEN	CEN	CEN
3	Corr. Bias Males 18+, except NB Males 18-29; 25 % Proc. Error	DSE	ACE	ACE	ACE	ACE	CEN	ACE	CEN
		UC	CEN	CEN	CEN	ACE	CEN	CEN	CEN
4	Corr. Bias Males 18+, except NB Males 18-29; 50 % Proc. Error	DSE	ACE	ACE	ACE	ACE	ACE	ACE	ACE
		UC	ACE	ACE	ACE	ACE	CEN	ACE	CEN
5	Corr. Bias Males 18+, except NB Males 18-29; 75 % Proc. Error	DSE	ACE	ACE	ACE	ACE	ACE	ACE	ACE
		UC	ACE	ACE	ACE	ACE	CEN	ACE	CEN
6	Corr. Bias Males 18+, except NB Males 18-29; 100 % Proc. Error	DSE	ACE	ACE	ACE	ACE	ACE	ACE	ACE
		UC	ACE	ACE	ACE	ACE	CEN	ACE	CEN
7	Corr. Bias Black Males 18+; 100 % Proc. Error	DSE	ACE	ACE	ACE	ACE	ACE	ACE	ACE
		UC	ACE	ACE	ACE	ACE	CEN	ACE	CEN
8	No Corr. Bias; 100 % Proc. Error	DSE	ACE	ACE	ACE	ACE	ACE	ACE	ACE
		UC	ACE	ACE	ACE	ACE	CEN	ACE	CEN

<sup>2</sup>Except for correlation bias, the other bias components are based on 1990 PES evaluations.

**Table 6. A.C.E. or Census More Accurate for Congressional Districts Shares?**

Shaded cell indicates a change in loss function decision due to synthetic bias										
Model	DSE Bias <sup>3</sup>	Distr. Method	Synthetic Bias Model (Artificial Population)							
			None	1	2	3	4	5	6	
1	Corr. Bias Males 18+; 100 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
2	Corr. Bias Males 18+, except NB Males 18-29; 0 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
3	Corr. Bias Males 18+, except NB Males 18-29; 25 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
4	Corr. Bias Males 18+, except NB Males 18-29; 50 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
5	Corr. Bias Males 18+, except NB Males 18-29; 75 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
6	Corr. Bias Males 18+, except NB Males 18-29; 100 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
7	Corr. Bias Black Males 18+; 100 % Proc. Error	DSE UC	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE	ACE ACE
8	No Corr. Bias; 100 % Proc. Error	DSE UC	CEN CEN	CEN CEN	CEN CEN	ACE ACE	CEN CEN	CEN CEN	CEN CEN	CEN CEN

<sup>3</sup>Except for correlation bias, the other bias components are based on 1990 PES evaluations.

**Table 7a: Synthetic Bias Correction for State Levels (Models 1-4)**

Artificial Population	Bias Model	Synthetic Method	Census Loss minus A.C.E. Loss	Synthetic Bias Correction	Relative Bias	Corrected Loss	Change Decision
1	1	1	9024.4	-55.88	-0.62%	8.97E+03	No
2	1	1	9024.4	-1.32	-0.01%	9.02E+03	No
3	1	1	9024.4	529.56	5.87%	9.55E+03	No
4	1	1	9024.4	-736.40	-8.16%	8.29E+03	No
5	1	1	9024.4	-1.32	-0.01%	9.02E+03	No
6	1	1	9024.4	-736.40	-8.16%	8.29E+03	No
1	1	2	7935.8	-55.88	-0.70%	7.88E+03	No
2	1	2	7935.8	-1.32	-0.02%	7.93E+03	No
3	1	2	7935.8	529.56	6.67%	8.47E+03	No
4	1	2	7935.8	-736.40	-9.28%	7.20E+03	No
5	1	2	7935.8	-1.32	-0.02%	7.93E+03	No
6	1	2	7935.8	-736.40	-9.28%	7.20E+03	No
1	2	1	46593	-55.88	-0.12%	4.65E+04	No
2	2	1	46593	-1.32	-0.00%	4.66E+04	No
3	2	1	46593	529.56	1.14%	4.71E+04	No
4	2	1	46593	-736.40	-1.58%	4.59E+04	No
5	2	1	46593	-1.32	-0.00%	4.66E+04	No
6	2	1	46593	-736.40	-1.58%	4.59E+04	No
1	2	2	46197	-55.88	-0.12%	4.61E+04	No
2	2	2	46197	-1.32	-0.00%	4.62E+04	No
3	2	2	46197	529.56	1.15%	4.67E+04	No
4	2	2	46197	-736.40	-1.59%	4.55E+04	No
5	2	2	46197	-1.32	-0.00%	4.62E+04	No
6	2	2	46197	-736.40	-1.59%	4.55E+04	No
1	3	1	39361	-55.88	-0.14%	3.93E+04	No
2	3	1	39361	-1.32	-0.00%	3.94E+04	No
3	3	1	39361	529.56	1.35%	3.99E+04	No
4	3	1	39361	-736.40	-1.87%	3.86E+04	No
5	3	1	39361	-1.32	-0.00%	3.94E+04	No
6	3	1	39361	-736.40	-1.87%	3.86E+04	No
1	3	2	38778	-55.88	-0.14%	3.87E+04	No
2	3	2	38778	-1.32	-0.00%	3.88E+04	No
3	3	2	38778	529.56	1.37%	3.93E+04	No
4	3	2	38778	-736.40	-1.90%	3.80E+04	No
5	3	2	38778	-1.32	-0.00%	3.88E+04	No
6	3	2	38778	-736.40	-1.90%	3.80E+04	No
1	4	1	32161	-55.88	-0.17%	3.21E+04	No
2	4	1	32161	-1.32	-0.00%	3.22E+04	No
3	4	1	32161	529.56	1.65%	3.27E+04	No
4	4	1	32161	-736.40	-2.29%	3.14E+04	No
5	4	1	32161	-1.32	-0.00%	3.22E+04	No
6	4	1	32161	-736.40	-2.29%	3.14E+04	No
1	4	2	31403	-55.88	-0.18%	3.13E+04	No
2	4	2	31403	-1.32	-0.00%	3.14E+04	No
3	4	2	31403	529.56	1.69%	3.19E+04	No
4	4	2	31403	-736.40	-2.34%	3.07E+04	No
5	4	2	31403	-1.32	-0.00%	3.14E+04	No
6	4	2	31403	-736.40	-2.34%	3.07E+04	No

Table 7b: Synthetic Bias Correction for State Levels (Models 5-8)

Artificial Population	Bias Model	Synthetic Method	Census Loss minus A.C.E. Loss	Synthetic Bias Correction	Relative Bias	Corrected Loss	Change Decision
1	5	1	25009	-55.88	-0.22%	2.50E+04	No
2	5	1	25009	-1.32	-0.01%	2.50E+04	No
3	5	1	25009	529.56	2.12%	2.55E+04	No
4	5	1	25009	-736.40	-2.94%	2.43E+04	No
5	5	1	25009	-1.32	-0.01%	2.50E+04	No
6	5	1	25009	-736.40	-2.94%	2.43E+04	No
1	5	2	24065	-55.88	-0.23%	2.40E+04	No
2	5	2	24065	-1.32	-0.01%	2.41E+04	No
3	5	2	24065	529.56	2.20%	2.46E+04	No
4	5	2	24065	-736.40	-3.06%	2.33E+04	No
5	5	2	24065	-1.32	-0.01%	2.41E+04	No
6	5	2	24065	-736.40	-3.06%	2.33E+04	No
1	6	1	17871.3	-55.88	-0.31%	1.78E+04	No
2	6	1	17871.3	-1.32	-0.01%	1.79E+04	No
3	6	1	17871.3	529.56	2.96%	1.84E+04	No
4	6	1	17871.3	-736.40	-4.12%	1.71E+04	No
5	6	1	17871.3	-1.32	-0.01%	1.79E+04	No
6	6	1	17871.3	-736.40	-4.12%	1.71E+04	No
1	6	2	16766	-55.88	-0.33%	1.67E+04	No
2	6	2	16766	-1.32	-0.01%	1.68E+04	No
3	6	2	16766	529.56	3.16%	1.73E+04	No
4	6	2	16766	-736.40	-4.39%	1.60E+04	No
5	6	2	16766	-1.32	-0.01%	1.68E+04	No
6	6	2	16766	-736.40	-4.39%	1.60E+04	No
1	7	1	10092.1	-55.88	-0.55%	1.00E+04	No
2	7	1	10092.1	-1.32	-0.01%	1.01E+04	No
3	7	1	10092.1	529.56	5.25%	1.06E+04	No
4	7	1	10092.1	-736.40	-7.30%	9.36E+03	No
5	7	1	10092.1	-1.32	-0.01%	1.01E+04	No
6	7	1	10092.1	-736.40	-7.30%	9.36E+03	No
1	7	2	8985.9	-55.88	-0.62%	8.93E+03	No
2	7	2	8985.9	-1.32	-0.01%	8.98E+03	No
3	7	2	8985.9	529.56	5.89%	9.52E+03	No
4	7	2	8985.9	-736.40	-8.20%	8.25E+03	No
5	7	2	8985.9	-1.32	-0.01%	8.98E+03	No
6	7	2	8985.9	-736.40	-8.20%	8.25E+03	No
1	8	1	-7591.5	-55.88	0.74%	-7.65E+03	No
2	8	1	-7591.5	-1.32	0.02%	-7.59E+03	No
3	8	1	-7591.5	529.56	-6.98%	-7.06E+03	No
4	8	1	-7591.5	-736.40	9.70%	-8.33E+03	No
5	8	1	-7591.5	-1.32	0.02%	-7.59E+03	No
6	8	1	-7591.5	-736.40	9.70%	-8.33E+03	No
1	8	2	-8759.7	-55.88	0.64%	-8.82E+03	No
2	8	2	-8759.7	-1.32	0.02%	-8.76E+03	No
3	8	2	-8759.7	529.56	-6.05%	-8.23E+03	No
4	8	2	-8759.7	-736.40	8.41%	-9.50E+03	No
5	8	2	-8759.7	-1.32	0.02%	-8.76E+03	No
6	8	2	-8759.7	-736.40	8.41%	-9.50E+03	No

Table 8a: Synthetic Bias Correction for State Shares (Models 1-4)

Artificial Population	Bias Model	Synthetic Method	Census Loss minus A.C.E. Loss	Synthetic Bias Correction	Relative Bias	Corrected Loss	Change Decision
1	1	1	5.45E-06	-1.95E-07	-3.59%	5.25E-06	No
2	1	1	5.45E-06	-4.61E-09	-0.08%	5.44E-06	No
3	1	1	5.45E-06	1.85E-06	34.00%	7.30E-06	No
4	1	1	5.45E-06	-2.58E-06	-47.29%	2.87E-06	No
5	1	1	5.45E-06	-4.61E-09	-0.08%	5.44E-06	No
6	1	1	5.45E-06	-2.58E-06	-47.29%	2.87E-06	No
1	1	2	1.35E-06	-1.95E-07	-14.52%	1.15E-06	No
2	1	2	1.35E-06	-4.61E-09	-0.34%	1.34E-06	No
3	1	2	1.35E-06	1.85E-06	137.60%	3.20E-06	No
4	1	2	1.35E-06	-2.58E-06	-191.35%	-1.23E-06	Yes
5	1	2	1.35E-06	-4.61E-09	-0.34%	1.34E-06	No
6	1	2	1.35E-06	-2.58E-06	-191.35%	-1.23E-06	Yes
1	2	1	8.25E-07	-1.95E-07	-23.58%	6.30E-07	No
2	2	1	8.25E-07	-4.59E-09	-0.56%	8.20E-07	No
3	2	1	8.25E-07	1.84E-06	223.48%	2.67E-06	No
4	2	1	8.25E-07	-2.56E-06	-310.77%	-1.74E-06	Yes
5	2	1	8.25E-07	-4.59E-09	-0.56%	8.20E-07	No
6	2	1	8.25E-07	-2.56E-06	-310.77%	-1.74E-06	Yes
1	2	2	-7.74E-07	-1.95E-07	25.14%	-9.69E-07	No
2	2	2	-7.74E-07	-4.59E-09	0.59%	-7.79E-07	No
3	2	2	-7.74E-07	1.84E-06	-238.20%	1.07E-06	Yes
4	2	2	-7.74E-07	-2.56E-06	331.24%	-3.34E-06	No
5	2	2	-7.74E-07	-4.59E-09	0.59%	-7.79E-07	No
6	2	2	-7.74E-07	-2.56E-06	331.24%	-3.34E-06	No
1	3	1	2.10E-06	-1.95E-07	-9.29%	1.90E-06	No
2	3	1	2.10E-06	-4.60E-09	-0.22%	2.09E-06	No
3	3	1	2.10E-06	1.85E-06	88.06%	3.94E-06	No
4	3	1	2.10E-06	-2.57E-06	-122.46%	-4.71E-07	Yes
5	3	1	2.10E-06	-4.60E-09	-0.22%	2.09E-06	No
6	3	1	2.10E-06	-2.57E-06	-122.46%	-4.71E-07	Yes
1	3	2	-1.35E-07	-1.95E-07	144.29%	-3.30E-07	No
2	3	2	-1.35E-07	-4.60E-09	3.41%	-1.40E-07	No
3	3	2	-1.35E-07	1.85E-06	1367.26%	1.71E-06	Yes
4	3	2	-1.35E-07	-2.57E-06	1901.33%	-2.70E-06	No
5	3	2	-1.35E-07	-4.60E-09	3.41%	-1.40E-07	No
6	3	2	-1.35E-07	-2.57E-06	1901.33%	-2.70E-06	No
1	4	1	3.37E-06	-1.95E-07	-5.79%	3.17E-06	No
2	4	1	3.37E-06	-4.60E-09	-0.14%	3.36E-06	No
3	4	1	3.37E-06	1.85E-06	54.87%	5.22E-06	No
4	4	1	3.37E-06	-2.57E-06	-76.30%	7.98E-07	No
5	4	1	3.37E-06	-4.60E-09	-0.14%	3.36E-06	No
6	4	1	3.37E-06	-2.57E-06	-76.30%	7.98E-07	No
1	4	2	5.14E-07	-1.95E-07	-37.94%	3.19E-07	No
2	4	2	5.14E-07	-4.60E-09	-0.90%	5.09E-07	No
3	4	2	5.14E-07	1.85E-06	359.52%	2.36E-06	No
4	4	2	5.14E-07	-2.57E-06	-499.95%	-2.06E-06	Yes
5	4	2	5.14E-07	-4.60E-09	-0.90%	5.09E-07	No
6	4	2	5.14E-07	-2.57E-06	-499.95%	-2.06E-06	Yes

Table 8b: Synthetic Bias Correction for State Shares (Models 5-8)

Artificial Population	Bias Model	Synthetic Method	Census Loss minus A.C.E. Loss	Synthetic Bias Correction	Relative Bias	Corrected Loss	Change Decision
1	5	1	4.64E-06	-1.95E-07	-4.21%	4.44E-06	No
2	5	1	4.64E-06	-4.61E-09	-0.10%	4.63E-06	No
3	5	1	4.64E-06	1.85E-06	39.88%	6.49E-06	No
4	5	1	4.64E-06	-2.57E-06	-55.46%	2.07E-06	No
5	5	1	4.64E-06	-4.61E-09	-0.10%	4.63E-06	No
6	5	1	4.64E-06	-2.57E-06	-55.46%	2.07E-06	No
1	5	2	1.16E-06	-1.95E-07	-16.86%	9.63E-07	No
2	5	2	1.16E-06	-4.61E-09	-0.40%	1.15E-06	No
3	5	2	1.16E-06	1.85E-06	159.76%	3.01E-06	No
4	5	2	1.16E-06	-2.57E-06	-222.17%	-1.41E-06	Yes
5	5	2	1.16E-06	-4.61E-09	-0.40%	1.15E-06	No
6	5	2	1.16E-06	-2.57E-06	-222.17%	-1.41E-06	Yes
1	6	1	5.92E-06	-1.95E-07	-3.30%	5.72E-06	No
2	6	1	5.92E-06	-4.61E-09	-0.08%	5.91E-06	No
3	6	1	5.92E-06	1.85E-06	31.30%	7.77E-06	No
4	6	1	5.92E-06	-2.58E-06	-43.52%	3.34E-06	No
5	6	1	5.92E-06	-4.61E-09	-0.08%	5.91E-06	No
6	6	1	5.92E-06	-2.58E-06	-43.52%	3.34E-06	No
1	6	2	1.81E-06	-1.95E-07	-10.81%	1.61E-06	No
2	6	2	1.81E-06	-4.61E-09	-0.26%	1.80E-06	No
3	6	2	1.81E-06	1.85E-06	102.44%	3.66E-06	No
4	6	2	1.81E-06	-2.58E-06	-142.46%	-7.68E-07	Yes
5	6	2	1.81E-06	-4.61E-09	-0.26%	1.80E-06	No
6	6	2	1.81E-06	-2.58E-06	-142.46%	-7.68E-07	Yes
1	7	1	6.32E-06	-1.95E-07	-3.09%	6.12E-06	No
2	7	1	6.32E-06	-4.61E-09	-0.07%	6.31E-06	No
3	7	1	6.32E-06	1.85E-06	29.32%	8.17E-06	No
4	7	1	6.32E-06	-2.58E-06	-40.77%	3.74E-06	No
5	7	1	6.32E-06	-4.61E-09	-0.07%	6.31E-06	No
6	7	1	6.32E-06	-2.58E-06	-40.77%	3.74E-06	No
1	7	2	2.21E-06	-1.95E-07	-8.84%	2.01E-06	No
2	7	2	2.21E-06	-4.61E-09	-0.21%	2.21E-06	No
3	7	2	2.21E-06	1.85E-06	83.81%	4.06E-06	No
4	7	2	2.21E-06	-2.58E-06	-116.54%	-3.66E-07	Yes
5	7	2	2.21E-06	-4.61E-09	-0.21%	2.21E-06	No
6	7	2	2.21E-06	-2.58E-06	-116.54%	-3.66E-07	Yes
1	8	1	4.77E-06	-1.95E-07	-4.10%	4.57E-06	No
2	8	1	4.77E-06	-4.61E-09	-0.10%	4.76E-06	No
3	8	1	4.77E-06	1.85E-06	38.84%	6.62E-06	No
4	8	1	4.77E-06	-2.58E-06	-54.01%	2.19E-06	No
5	8	1	4.77E-06	-4.61E-09	-0.10%	4.76E-06	No
6	8	1	4.77E-06	-2.58E-06	-54.01%	2.19E-06	No
1	8	2	6.40E-07	-1.95E-07	-30.54%	4.45E-07	No
2	8	2	6.40E-07	-4.61E-09	-0.72%	6.35E-07	No
3	8	2	6.40E-07	1.85E-06	289.39%	2.49E-06	No
4	8	2	6.40E-07	-2.58E-06	-402.43%	-1.94E-06	Yes
5	8	2	6.40E-07	-4.61E-09	-0.72%	6.35E-07	No
6	8	2	6.40E-07	-2.58E-06	-402.43%	-1.94E-06	Yes

Table 9a: Synthetic Bias Correction for Congressional District Shares (Models 1-4)

Artificial Population	Bias Model	Synthetic Method	Census Loss minus A.C.E. Loss	Synthetic Bias Correction	Relative Bias	Corrected Loss	Change Decision
1	1	1	1.57E+09	-1.63E+08	-10.44%	1.40E+09	No
2	1	1	1.57E+09	-3.42E+07	-2.18%	1.53E+09	No
3	1	1	1.57E+09	1.95E+09	124.54%	3.51E+09	No
4	1	1	1.57E+09	-5.96E+08	-38.09%	9.69E+08	No
5	1	1	1.57E+09	-3.42E+07	-2.18%	1.53E+09	No
6	1	1	1.57E+09	-5.93E+08	-37.92%	9.72E+08	No
1	1	2	1.37E+09	-1.63E+08	-11.97%	1.20E+09	No
2	1	2	1.37E+09	-3.42E+07	-2.50%	1.33E+09	No
3	1	2	1.37E+09	1.95E+09	142.74%	3.31E+09	No
4	1	2	1.37E+09	-5.96E+08	-43.68%	7.69E+08	No
5	1	2	1.37E+09	-3.42E+07	-2.50%	1.33E+09	No
6	1	2	1.37E+09	-5.94E+08	-43.50%	7.71E+08	No
1	2	1	2.11E+09	-1.62E+08	-7.71%	1.94E+09	No
2	2	1	2.11E+09	-3.39E+07	-1.61%	2.07E+09	No
3	2	1	2.11E+09	1.94E+09	92.16%	4.05E+09	No
4	2	1	2.11E+09	-5.93E+08	-28.18%	1.51E+09	No
5	2	1	2.11E+09	-3.39E+07	-1.61%	2.07E+09	No
6	2	1	2.11E+09	-5.93E+08	-28.15%	1.51E+09	No
1	2	2	2.05E+09	-1.62E+08	-7.92%	1.89E+09	No
2	2	2	2.05E+09	-3.39E+07	-1.66%	2.02E+09	No
3	2	2	2.05E+09	1.94E+09	94.62%	3.99E+09	No
4	2	2	2.05E+09	-5.93E+08	-28.93%	1.46E+09	No
5	2	2	2.05E+09	-3.39E+07	-1.66%	2.02E+09	No
6	2	2	2.05E+09	-5.93E+08	-28.91%	1.46E+09	No
1	3	1	1.98E+09	-1.63E+08	-8.21%	1.82E+09	No
2	3	1	1.98E+09	-3.40E+07	-1.71%	1.95E+09	No
3	3	1	1.98E+09	1.94E+09	98.00%	3.92E+09	No
4	3	1	1.98E+09	-5.94E+08	-29.97%	1.39E+09	No
5	3	1	1.98E+09	-3.40E+07	-1.71%	1.95E+09	No
6	3	1	1.98E+09	-5.93E+08	-29.91%	1.39E+09	No
1	3	2	1.89E+09	-1.63E+08	-8.61%	1.73E+09	No
2	3	2	1.89E+09	-3.40E+07	-1.80%	1.86E+09	No
3	3	2	1.89E+09	1.94E+09	102.75%	3.83E+09	No
4	3	2	1.89E+09	-5.94E+08	-31.42%	1.30E+09	No
5	3	2	1.89E+09	-3.40E+07	-1.80%	1.86E+09	No
6	3	2	1.89E+09	-5.93E+08	-31.37%	1.30E+09	No
1	4	1	1.86E+09	-1.63E+08	-8.76%	1.70E+09	No
2	4	1	1.86E+09	-3.40E+07	-1.83%	1.82E+09	No
3	4	1	1.86E+09	1.94E+09	104.60%	3.80E+09	No
4	4	1	1.86E+09	-5.95E+08	-31.99%	1.26E+09	No
5	4	1	1.86E+09	-3.40E+07	-1.83%	1.82E+09	No
6	4	1	1.86E+09	-5.93E+08	-31.90%	1.27E+09	No
1	4	2	1.73E+09	-1.63E+08	-9.41%	1.57E+09	No
2	4	2	1.73E+09	-3.40E+07	-1.97%	1.70E+09	No
3	4	2	1.73E+09	1.94E+09	112.31%	3.68E+09	No
4	4	2	1.73E+09	-5.95E+08	-34.36%	1.14E+09	No
5	4	2	1.73E+09	-3.40E+07	-1.97%	1.70E+09	No
6	4	2	1.73E+09	-5.93E+08	-34.27%	1.14E+09	No

Table 9b: Synthetic Bias Correction for Congressional District Shares (Models 5-8)

Artificial Population	Bias Model	Synthetic Method	Census Loss minus A.C.E. Loss	Synthetic Bias Correction	Relative Bias	Corrected Loss	Change Decision
1	5	1	1.74E+09	-1.63E+08	-9.40%	1.57E+09	No
2	5	1	1.74E+09	-3.41E+07	-1.96%	1.70E+09	No
3	5	1	1.74E+09	1.95E+09	112.15%	3.68E+09	No
4	5	1	1.74E+09	-5.95E+08	-34.29%	1.14E+09	No
5	5	1	1.74E+09	-3.41E+07	-1.96%	1.70E+09	No
6	5	1	1.74E+09	-5.93E+08	-34.17%	1.14E+09	No
1	5	2	1.57E+09	-1.63E+08	-10.38%	1.41E+09	No
2	5	2	1.57E+09	-3.41E+07	-2.17%	1.54E+09	No
3	5	2	1.57E+09	1.95E+09	123.81%	3.52E+09	No
4	5	2	1.57E+09	-5.95E+08	-37.88%	9.77E+08	No
5	5	2	1.57E+09	-3.41E+07	-2.17%	1.54E+09	No
6	5	2	1.57E+09	-5.93E+08	-37.75%	9.79E+08	No
1	6	1	1.61E+09	-1.63E+08	-10.12%	1.45E+09	No
2	6	1	1.61E+09	-3.42E+07	-2.12%	1.58E+09	No
3	6	1	1.61E+09	1.95E+09	120.76%	3.56E+09	No
4	6	1	1.61E+09	-5.96E+08	-36.93%	1.02E+09	No
5	6	1	1.61E+09	-3.42E+07	-2.12%	1.58E+09	No
6	6	1	1.61E+09	-5.93E+08	-36.77%	1.02E+09	No
1	6	2	1.41E+09	-1.63E+08	-11.56%	1.25E+09	No
2	6	2	1.41E+09	-3.42E+07	-2.42%	1.38E+09	No
3	6	2	1.41E+09	1.95E+09	137.89%	3.36E+09	No
4	6	2	1.41E+09	-5.96E+08	-42.20%	8.17E+08	No
5	6	2	1.41E+09	-3.42E+07	-2.42%	1.38E+09	No
6	6	2	1.41E+09	-5.94E+08	-42.02%	8.19E+08	No
1	7	1	1.83E+09	-1.63E+08	-8.92%	1.67E+09	No
2	7	1	1.83E+09	-3.42E+07	-1.87%	1.80E+09	No
3	7	1	1.83E+09	1.95E+09	106.45%	3.78E+09	No
4	7	1	1.83E+09	-5.96E+08	-32.55%	1.23E+09	No
5	7	1	1.83E+09	-3.41E+07	-1.87%	1.80E+09	No
6	7	1	1.83E+09	-5.93E+08	-32.41%	1.24E+09	No
1	7	2	1.63E+09	-1.63E+08	-10.02%	1.47E+09	No
2	7	2	1.63E+09	-3.42E+07	-2.09%	1.60E+09	No
3	7	2	1.63E+09	1.95E+09	119.46%	3.58E+09	No
4	7	2	1.63E+09	-5.96E+08	-36.56%	1.03E+09	No
5	7	2	1.63E+09	-3.42E+07	-2.09%	1.60E+09	No
6	7	2	1.63E+09	-5.94E+08	-36.41%	1.04E+09	No
1	8	1	-8.00E+06	-1.63E+08	2042.18%	-1.71E+08	No
2	8	1	-8.00E+06	-3.42E+07	426.90%	-4.22E+07	No
3	8	1	-8.00E+06	1.95E+09	-24363.00%	1.94E+09	Yes
4	8	1	-8.00E+06	-5.96E+08	7450.23%	-6.04E+08	No
5	8	1	-8.00E+06	-3.41E+07	426.85%	-4.21E+07	No
6	8	1	-8.00E+06	-5.93E+08	7417.59%	-6.01E+08	No
1	8	2	-2.14E+08	-1.63E+08	76.35%	-3.77E+08	No
2	8	2	-2.14E+08	-3.42E+07	15.96%	-2.48E+08	No
3	8	2	-2.14E+08	1.95E+09	-910.43%	1.73E+09	Yes
4	8	2	-2.14E+08	-5.96E+08	278.62%	-8.10E+08	No
5	8	2	-2.14E+08	-3.42E+07	15.96%	-2.48E+08	No
6	8	2	-2.14E+08	-5.94E+08	277.46%	-8.08E+08	No

# APPENDIX

## Forming artificial populations

Let  $X$  denote a surrogate for weighted non-matches and  $Y$  denote a surrogate for weighted erroneous enumerations.

$DSE_j$  = the Dual System Estimate for Post-stratum  $j$

$E_j$  = the weighted  $E$  sample total in post-stratum  $j$

$CE_j$  = the weighted  $E$  sample number of correct enumerations in post-stratum  $j$

$EE_j$  = the weighted  $E$  sample number of erroneous enumerations in post-stratum  $j$

$Cen_{.j}$  = the census count in post-stratum  $j$

Note that for any variable  $V$ ,  $V_{.j}$  is the sum of  $V_{ij}$  over areas  $i$ .

Define the estimated weighted non-matches as follows:

$$NONMATCH_j = DSE_j \& Cen_{.j} \left( \frac{CE_j}{E_j} \right)$$

Define the estimated weighted erroneous enumerations as follows:

$$ERR_j = Cen_{.j} \left( \frac{EE_j}{E_j} \right)$$

Denote the estimated DSE bias (estimated from the total Error Model including correlation bias) as  $\hat{D}_j$

$N_{ij}$  is the artificial population count and  $Cen_{ij}$  is the census count for area  $i$ , post-stratum  $j$ .

$$N_{ij} = Cen_{ij} \% X_{ij} \frac{NONMATCH_j}{X_{.j}} \& Y_{ij} \frac{ERR_j}{Y_j} \& Cen_{ij} \frac{\hat{D}_j}{Cen_{.j}} \quad (1)$$

$$N_{.j} = Cen_{.j} \% NONMATCH_j \& ERR_j \& \hat{D}_j = Cen_{.j} \% DSE_j \& Cen_{.j} \& \hat{D}_j = DSE_j \& \hat{D}_j$$

Equation (1) was used for Artificial Populations 1, 2, 3, and 4. For Artificial Populations 2 and 4,  $X$  and  $Y$  represented the same variable. In order to consider alternatives that use a

surrogate variable instead of the Census counts to allocate the DSE bias,  $\hat{D}_j$ , Artificial Populations 5 and 6 were created using the single surrogate variable for Artificial Populations 2, and 4 respectively. Denoting the single surrogate variable by  $X_j$ , equation (2) is the artificial population count used for Artificial Populations 5 and 6.

$$N_{ij} = Cen_{ij} \% X_{ij} \frac{(DSE_j \& Cen_{.j} \& \hat{D}_j)}{X_{.j}} \quad (2)$$

The artificial populations were selected by computing the, within post-strata, correlation between

$z = (\text{Weighted P-sample Non-matches}) - (\text{Weighted E-sample erroneous enumerations})$ .  
and  $N_{ij}$  &  $Cen_{ij}$ , at the A.C.E. block cluster level.

## CORRECTION FOR SYNTHETIC BIAS IN LOSS FUNCTION ANALYSIS

Notation:

$D_g$  = the census squared error loss minus the A.C.E. squared error loss using synthetic target estimates.

$D_t$  = the census squared error loss minus the A.C.E. squared error loss using "true" target estimates.

The loss function analysis output is in terms of expected losses using the synthetic target estimates, i.e.,  $\Delta_g = E(D_g)$ . However, we would like to know  $\Delta_t = E(D_t)$ . Therefore, we develop an expression for a bias correction term,  $B$ , to be added to  $\Delta_g$  to correct loss function results for synthetic bias so that

$$\Delta_t = \Delta_g \% B.$$

Define:

$w_i$  = the squared error loss function weight for area  $i$ .

Note: For this derivation, assume the same weight is used for the A.C.E. Loss and the Census Loss. For state counts and state shares, the input loss function difference used A.C.E. data for the A.C.E. weight and Census data for the Census weight. For the bias correction term, we assume that Census data was used for both the A.C.E. Loss and the Census Loss. This

assumption has negligible effect on results. For CD and County Shares, the input loss function difference used Census data for both the A.C.E. Loss and the Census loss so no assumption is necessary.

$Cen_i$  = the census count for area i

$N_i$  = the "true" target estimate for area i

$\tilde{N}_i$  = the synthetic target estimate for area i =  $\sum_j \frac{C_{ij}}{C_{.j}}(DSE_j \text{ \& } \hat{D}_j)$

$\hat{N}_i$  = the A.C.E. synthetic estimate for area i (includes DSE post-stratum biases)

$$= \sum_j \frac{C_{ij}}{C_{.j}} DSE_j$$

$b_i$  = bias in the post-stratum level DSE including correlation bias allocated to area i

By definition,

$$a_i = E(\hat{N}_i) - \tilde{N}_i + b_i$$

Using this notation:

$$D_g = \sum_i [w_i(Cen_i \& \tilde{N}_i)^2 \text{ \& } w_i(\hat{N}_i \& \tilde{N}_i)^2], \text{ and}$$

$$D_t = \sum_i [w_i(Cen_i \& N_i)^2 \text{ \& } w_i(\hat{N}_i \& N_i)^2]$$

$$= D_g + 2 \sum_i w_i(\tilde{N}_i \& N_i)(Cen_i \& \hat{N}_i)$$

The resulting expected difference is:

$$\begin{aligned} \Delta_t &= \Delta_g + 2 \sum_i w_i(\tilde{N}_i \& N_i)(Cen_i \& a_i) \\ &= \Delta_g + 2 \sum_i w_i(\tilde{N}_i \& N_i)(Cen_i \& \tilde{N}_i \& b_i), \end{aligned}$$

So  $B = \text{bias correction term} = 2 \sum_i w_i (\tilde{N}_i \& N_i) (Cen_i \& \tilde{N}_i \& b_i)$ .

Estimates for this bias term are made by using artificial population values for the terms  $N_i$  and  $\tilde{N}_i$  and by estimating  $b_i$  with  $\sum_j \frac{Cen_{ij}}{Cen_{.j}} \hat{D}_j$ . An analogous approach is used for shares.